Naval Oceanographic and
Atmospheric Research Laboratory

Technical Note 241
September 1992

SEVERE WEATHER GUIDE MEDITERRANEAN PORTS

49. THESSALONIKI

ABSTRACT

This handbook for the port of Thessaloniki, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

ACKNOWLEDGMENTS

The support of the sponsor, Naval Oceanography Command, Stennis Space Center, MS, LCDR E. Steiner, USN, Program Element O&M,N-1, is gratefully acknowledged.

CONTENTS

FOREWORD

This handbook on Mediterranean Ports was developed as part of an ongoing effort at the Meteorology Division, Naval Research Laboratory (NRL), Monterey, to create products for direct application to Fleet Operations. The research was conducted in response to Commander Naval Oceanography Command (COMNAVOCEANCOM) requirements validated by the Chief of Naval Operations (OP-096).

As mentioned in the preface, the Mediterranean region is unique in that several areas exist where local winds can cause dangerous operating conditions. This handbook will provide the ship's captain with assistance in making decisions regarding the disposition of his ship when heavy winds and seas are encountered or forecast at various port locations.

Readers are urged to submit comments, suggestions for changes, deletions and/or additions to Naval Oceanography Command Center (NAVOCEANCOMCEN), Rota with a copy to the oceanographer, COMSIXTHFLT. They will then be passed on to NRL Monterey for review and incorporation as appropriate. This document will be a dynamic one, changing and improving as more and better information is obtained.

PORT INDEX

The following is a list of Mediterranean Ports that have been evaluated since 1988, with future ports and probable year of distribution also included. Computerized versions of these port guides are currently available for those ports with an asterisk (*). Those without the asterisk will be computerized in the near future. Contact the Naval Research Laboratory (NRL), Monterey or NOCC Rota for IBM compatible floppy disk copies.

NO.	PORT
*1	GAETA, ITALY
*2	NAPLES, ITALY
*3	CATANIA, ITALY
*4	AUGUSTA BAY, ITALY
*5	CAGLIARI, ITALY
*6	LA MADDALENA, ITALY
7	MARSEILLE, FRANCE
8	TOULON, FRANCE
9	VILLEFRANCHE, FRANCE
10	MALAGA, SPAIN
11	NICE, FRANCE
12	CANNES, FRANCE
13	MONACO
14	ASHDOD, ISRAEL
15	HAIFA, ISRAEL
16	BARCELONA, SPAIN
17	PALMA, SPAIN
18	IBIZA, SPAIN
19	POLLENSA BAY, SPAIN
20	LIVORNO, ITALY
21	LA SPEZIA, ITALY
22	VENICE, ITALY
23	TRIESTE, ITALY
*24	CARTAGENA, SPAIN
*25	VALENCIA, SPAIN
*26	SAN REMO, ITALY
*27	GENOA, ITALY
*28	PORTO TORRES, ITALY
*29	PALERMO, ITALY
*30	MESSINA, ITALY
*31	TAORMINA, ITALY
*32	TARANTO, ITALY
*33	TANGIER, MOROCCO
*34	BENIDORM, SPAIN
*35	ROTA, SPAIN
*36	LIMASSOL, CYPRUS
*37	LARNACA, CYPRUS
*38	ALEXANDRIA, EGYPT
*39	PORT SAID, EGYPT
*40	BIZERTE, TUNISIA
*41	TUNIS, TUNISIA
*42	SOUSSE, TUNISIA
*43	SFAX, TUNISIA
*44	SOUDA BAY, CRETE
*45	PIRAEUS, GREECE
*46	KALAMATA, GREECE
*47	KERKIRA (CORFU), GREECE
*48	KITHIRA, GREECE
*49	THESSALONIKI, GREECE

1993	PORT
	VALLETTA, MALTA
	ISKENDERUN, TURKEY
	IZMIR, TURKEY
	ISTANBUL, TURKEY
	ANTALYA, TURKEY

PREFACE

Environmental phenomena such as strong winds, high waves, restrictions to visibility and thunderstorms can be hazardous to critical Fleet operations. The cause and effect of several of these phenomena are unique to the Mediterranean region and some prior knowledge of their characteristics would be helpful to ship's captains. The intent of this publication is to provide guidance to the captains for assistance in decision making.

The Mediterranean Sea region is an area where complicated topographical features influence weather patterns. Katabatic winds will flow through restricted mountain gaps or valleys and, as a result of the venturi effect, strengthen to storm intensity in a short period of time. As these winds exit and flow over port regions and coastal areas, anchored ships with large 'sail areas' may be blown aground. Also, hazardous sea state conditions are created, posing a danger for small boats ferrying personnel to and from port. At the same time, adjacent areas may be relatively calm. A glance at current weather charts may not always reveal the causes for these local effects which vary drastically from point to point.

Because of the irregular coast line and numerous islands in the Mediterranean, swell can be refracted around such barriers and come from directions which vary greatly with the wind. Anchored ships may experience winds and seas from one direction and swell from a different direction. These conditions can be extremely hazardous for tendered vessels. Moderate to heavy swell may also propagate outward in advance of a storm resulting in uncomfortable and sometimes dangerous conditions, especially during tending, refueling and boating operations.

This handbook addresses the various weather conditions, their local cause and effect and suggests some evasive action to be taken if necessary. Most of the major ports in the Mediterranean will be covered in this series of handbooks. A priority list, established by the Sixth Fleet, exists for the port studies conducted and this list will be followed as closely as possible in terms of scheduling publications.

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	PAGE NUMBER	ENTERED BY

1. GENERAL GUIDANCE

1.1 DESIGN

This handbook is designed to provide ship captains with a ready reference on hazardous weather and wave conditions in selected Mediterranean harbors. Section 2, the captain's summary, is an abbreviated version of section 3, the general information section intended for staff planners and meteorologists. Once section 3 has been read, it is not necessary to read section 2.

1.1.1 Objectives

The basic objective is to provide ship captains with a concise reference of hazards to ship activities that are caused by environmental conditions in various Mediterranean harbors, and to offer suggestions for precautionary and/or evasive actions. A secondary objective is to provide adequate background information on such hazards so that operational forecasters, or other interested parties, can quickly gain the local knowledge that is necessary to ensure high quality forecasts.

1.1.2 Approach

Information on harbor conditions and hazards was accumulated in the following manner:

A. A literature search for reference material was performed.
B. Cruise reports were reviewed.
C. Navy personnel with current or previous area experience were interviewed.
D. A preliminary report was developed which included questions on variou local conditions in specific harbors.
E. Port/harbor visits were made by NOARL personnel; considerable information was obtained through interviews with local pilots, tug masters, etc; and local reference material was obtained.
F. The cumulative information was reviewed, combined, and condensed for harbor studies.

1.1.3 Organization

The handbook contains two sections for each harbor. The first section summarizes harbor conditions and is intended for use as a quick reference by ship captains, navigators, inport/at sea OOD's, and other interested personnel. This section contains:

A. a brief narrative summary of environmental hazards,
B. a table display of vessel location/situation, potential environmental hazard, effect-precautionary/evasion actions, and advance indicators of potential environmental hazards,
C. local wind wave conditions, and
D. tables depicting the wave conditions resulting from propagation of deep water swell into the harbor.

The swell propagation information includes percent occurrence, average duration, and the period of maximum wave energy within height ranges of greater than 3.3 feet and greater than 6.6 feet. The details on the generation of sea and swell information are provided in Appendix A.

The second section contains additional details and background information on seasonal hazardous conditions. This section is directed to personnel who have a need for additional insights on environmental hazards and related weather events.

1.2 CONTENTS OF SPECIFIC HARBOR STUDIES

This handbook specifically addresses potential wind and wave related hazards to ships operating in various Mediterranean ports utilized by the U.S. Navy. It does not contain general purpose climatology and/or comprehensive forecast rules for weather conditions of a more benign nature.

The contents are intended for use in both pre-visit planning and in situ problem solving by either mariners or environmentalists. Potential haz-

ards related to both weather and waves are addressed. The oceanographic information includes some rather unique information relating to deep water swell propagating into harbor shallow water areas.

Emphasis is placed on the hazards related to wind, wind waves, and the propagation of deep water swell into the harbor areas. Various vessel locations/situations are considered, including moored, nesting, anchored, arriving/departing, and small boat operations. The potential problems and suggested precautionary/evasive actions for various combinations of environmental threats and vessel location/situation are provided. Local indicators of environmental hazards and possible evasion techniques are summarized for various scenarios.

CAUTIONARY NOTE: In September 1985 Hurricane Gloria raked the Norfolk, VA area while several US Navy ships were anchored on the muddy bottom of Chesapeake Bay. One important fact was revealed during this incident: Most all ships frigate size and larger dragged anchor, some more than others, in winds of over 50 knots. As winds and waves increased, ships 'fell into' the wave troughs, BROADSIDE TO THE WIND and became difficult or impossible to control.

This was a rare instance in which several ships of recent design were exposed to the same storm and much effort was put into the documentation of lessons learned. Chief among these was the suggestion to evade at sea rather than remain anchored at port whenever winds of such intensity are forecast.

2. CAPTAIN'S SUMMARY

The Port of Thessaloniki, Greece is located in the northwest Aegean Sea on the northern shore of the Gulf of Thessaloniki near 40°38'N, 22° 56'E (FICEURLANT, 1987) (Figure 2-1). It is about 300 n mi north of Crete and about 315 n mi west of Istanbul.

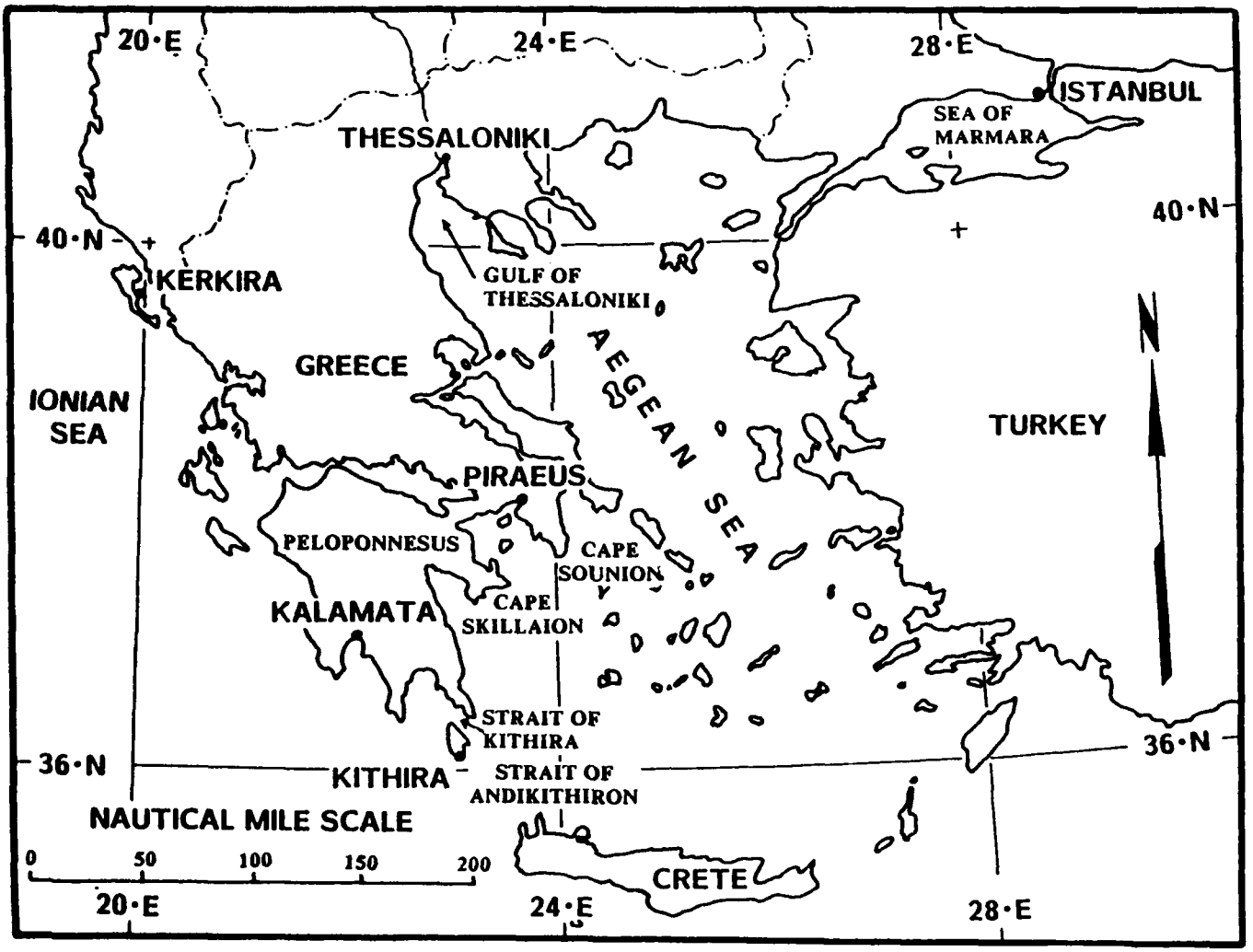


Figure 2-1. Ports of Greece and Surrounding Waters.

The Port is situated on the north shore of the Bay of Thessaloniki in the northernmost portion of the Gulf of Thessaloniki (Figure 2-2). The Port is in the western portion of the City of Thessaloniki which is situated on the slopes of a steep hill that extends along the eastern side of the Bay. A low lying flat coastal plain extends 20 to 30 n mi west and northwest from the Port. The plains include the mouth and delta area of the Vardar River which enters the Gulf of Thessaloniki about 10 n mi southwest of the Port. Mountainous terrain lies close along the western portion of the Gulf of Thessaloniki and around the northern and eastern side of the plains area. The Vardar River Gap extends through the mountains to the north producing a pass from which strong cold northerly winds flow during the winter.

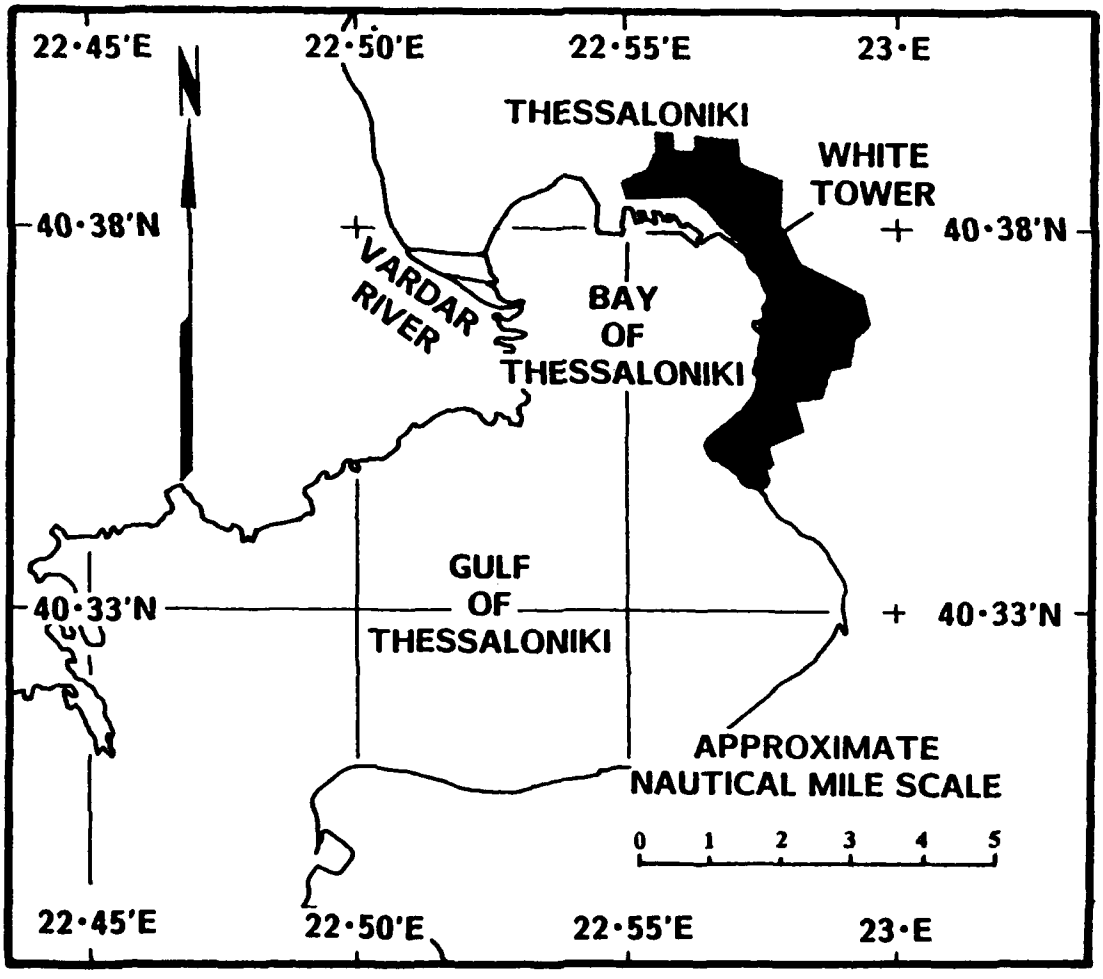


Figure 2-2. Approaches to the Port of Thessaloniki, Greece.

The Port of Thessaloniki is located on the northern shore of the Bay of Thessaloniki in the western part of the City of Thessaloniki. The harbor is formed by a large breakwater extending northwest and west along the coast for over 3000 ft (909 m) with moles near the ends which partially close off the harbor (Figure 2-3). Entrance can be made through either end. The eastern entrance has a width of 656 ft (200 m) and a depth of 35 ft (10.6 m); the western entrance has a width of 980 ft (299 m) and depth of 27 ft (8.2 m) (FICEURLANT, 1987). The Fleet Landing is generally made inboard or outboard of the eastern most mole. Fleet Landing can also be established near the American Consulate in the vicinity of the prominent white tower located about 3/4 n mi east of the eastern entrance of the harbor. This and other boat landings along the sea wall outside the harbor may become hazardous, during the summer late afternoon and evening period, when the sea breeze is at maximum strength.

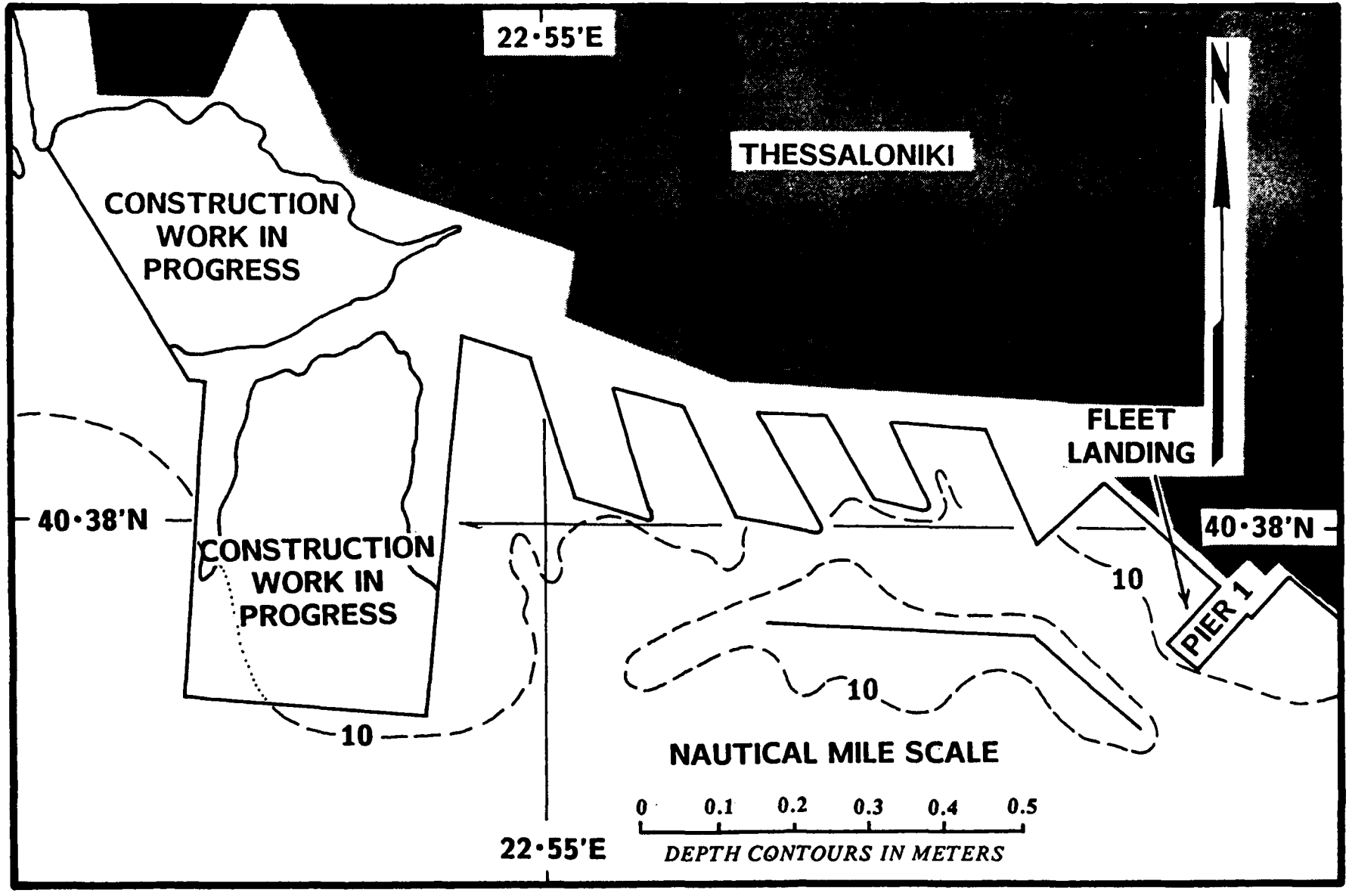


Figure 2-3. The Port of Thessaloniki, Greece.

The "conventional" port, located inboard from the breakwater, consists of five piers with a total length of about 4743 m (15,652 ft). A modern container terminal located just west of the conventional port provides a large sixth pier. Alongside depths of the conventional port range from 18 ft (5.5 m) to 40 ft (12 m). Any pier could be used for berthing. The preferred berthing for U.S. Navy ships, as well as the Fleet Landing, is on pier 1 (eastern pier).

Ships may anchor approximately 1 mile south of the eastern entrance (FICEURLANT, 1987) in depths of 48 ft (14.6 m) to 60 ft (18 m). During the 1990 Port Visit it was stated that anchorage should be made as close as allowed (1/2 n mi) to the breakwater for maximum protection. There are extensive shoals to the west along the low lying coastal area and delta region of the Vardar River. Grounding in soft mud is a frequent problem. The soft mud bottom extends into the anchorage area, and, as a result, the holding may be poor during the first hour until the anchor sinks deeper into the mud. The anchorage is exposed to wind from all directions and to waves from the southwest. There are no alternate anchorages in the Bay of Thessaloniki. The strongest winds experienced during winter are when cold northerlies flow out of the Vardar Gap. These winds tend to persist for 1 to 5 days and start with a sudden onset (Hydrographer of the Navy, 1968). Summer conditions are windy with daily afternoon and evening southerly sea breezes and occasional moderate dusty northeasterlies associated with regional Etesian winds.

Tides and currents are minimal. Maximum tides of 2 to 3 ft (1 m) occur during strong southerly winds. Strong outflow near the mouth of the Vardar River during March and April flood periods result in locally strong currents which can be a hazard during entry to the Bay of Thessaloniki.

Specific hazardous conditions, vessel situations, and suggested precautionary/evasive action scenarios are summarized in Table 2-1.

Table 2.1 Summary of Hazardous Environmental Conditions

HAZARDOUS CONDITIONS	INDICATORS OF POTENTIAL HAZARD	VES SITU
1. <u>Strong NW to N'ly winds</u> - Locally known as "Vardares", regionally as "Boras". * Strongest in winter, early spring. * Typical event 34-47 kt (force 8-9), waves 4-7 ft (1-2 m) and building offshore. Extreme event in last 20 years had wind over 64 kt (force 12). * Durations vary from 1 to 5 days. * Wind chill temperatures to -20°F (-29°C). * Strongest winds likely during morning period.	<u>Advance Warning</u> * High pressure advancing eastward over Europe with low pressure developing over or moving into the eastern Mediterranean. * Local onset of winds tends to be abrupt. <u>Duration</u> * Varies from 1 to 5 days, 2 to 3 days are typical.	(1) H a (2) S C (3) A
2. <u>Strong N to NE'ly winds</u> - Occur during most intense regional "Etesian" wind events. * Summer event. * Typical event 28-33 kt (force 7), waves 3 to 5 ft (1-1½ m), building offshore. * Blowing dust may restrict visibility. * Winds likely to decrease in afternoon, sea breeze counteracts.	<u>Advance Warning</u> * Increasing cloudiness over the Balkan Peninsula/Aegean Sea region on day before onset of "Etesian". * Thunderstorm activity during May-June and September-October periods, altocumulus clouds during July-August. <u>Duration</u> * Average about 2 days during May-June and September-October periods and 4 days during July-August. Periods of 5 to 10 days have occurred during July-August.	(1) H a

ental Conditions for the Port of Thessaloniki, Greece

D	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
ancing ope astern ads .	(1) Harbor Operations and Anchorage	a. THE MOST HAZARDOUS CONDITIONS EXPERIENCED. * Berthing and cargo handling may be curtailed. * Low wind chills necessitate cold weather procedures. * Vessels may drag anchor. * Anchorage should be as close in as possible.
5 days, ypical.	(2) Small Boat Operations	a. OPERATIONS OUTSIDE HARBOR CURTAILED. * Winds and waves increase offshore. * Short period wind waves will maximize hazards of alongside/well deck operations. * Winds and waves should be nearly aligned. * Lee side of vessels in anchorage will be to seaward.
	(3) Arriving/Departing	a. NAVIGATION HAZARDS, BAY ENTRANCE TO HARBOR. * Winds and waves increase offshore, extensive shoaling adjacent to channel and anchorage areas.
ness sea ore . vity nd tus -	(1) Harbor Operations and Anchorage	a. PRECAUTIONARY ACTIONS WILL LIMIT THREAT. * Infrequent warm season conditions. * Reversal of wind direction from prevailing southerly sea breezes. * Anchorage should be as close in as possible. * Blowing dust may be hazardous to exposed equipment/materials. * Lowest wind speeds likely in afternoon, scheduling factor.
ays nd ; .) days ng		

Table 2.1 (cont

HAZARDOUS CONDITIONS	INDICATORS OF POTENTIAL HAZARD
3. Strong S'ly winds - Associated with migratory cyclones. * Winter event. * Strongest S'ly winds in advance of cold front passages. Winds 17 to 27 kt (force 5-6), waves 4-7 ft (1-2 m). * Likely to be accompanied by low clouds, precipitation, reduced visibility. * May be followed by strong cold northerly winds.	Advance Warning * Storms approaching from the southwest or west. * May have originated as either Genoa Lows in the vicinity of Italy, or Sciroccos over North Africa. Duration * Generally 12 to 24 hours.

Table 2.1 (continued)

:ARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
	(2) Small Boat Operations	a. REVERSAL OF WINDWARD/LEEWARD EXPOSURES. * Reversal of wind direction from prevailing southerly sea breezes. * Lowest wind speeds likely in afternoon. * Scheduling factors. * Leeside of vessels in anchorage will be to seaward.
	(3) Arriving/Departing	a. WIND REVERSALS FROM TYPICAL SEA BREEZE REGIMES. * Offshore flow, morning maximum speeds, consider in scheduling.
ıing from or west. ıated as ows in the ıly, or North	(1) Harbor Operations and Anchorage	a. VESSEL DRIFT TOWARD SHOAL AREA. * SE'ly wind/waves will cause vessel movement toward shoal area. * Soft mud bottom may not hold for first hour or so, allow for initial anchor dragging toward shore. * Breakwater provides protection from waves inside harbor.
) 24	(2) Small Boat Operations	a. LANDINGS OUTSIDE HARBOR FULLY EXPOSED. * Small boat operations outside harbor are fully exposed to winds and choppy waves. * Fleet landing inside of harbor most protected. * Leeside of vessels in anchorage will be shoreward.
	(3) Arriving/Departing	a. VESSEL DRIFT WILL BE TOWARD SHOAL AREAS. * Extensive shoaling bounds north and west side of entrance and anchorage areas. * Clouds and precipitation may restrict visibility impacting on visual navigation. * Extreme conditions generally 12 hours or less with frontal passages, delay may be prudent.

Table 2.1 (cont

HAZARDOUS CONDITIONS	INDICATORS OF POTENTIAL HAZARD
4. Reduced visibility - Winter fog, summer smog. * Winter fog events may last 2 to 3 days, visibility near zero with only sight afternoon improvements. * Summer smog and haze nearly daily condition. Visibility reduced to 1-3 nm with afternoon improvement.	Advance Warning * Winter fog events occur when high pressure extends southward over the Balkan Peninsula and near calm wind conditions prevail. * Summer smog and haze are daily events during the warm season. Visibilities improve as local winds increase.

e 2.1 (continued)

)	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
s occur re i over sula and il. naze are ing the rove as ease.	(1) All Locations/ Situations	a. NEAR ZERO VISIBILITY IN WINTER FOG. * Vessel movements may be curtailed during morning minimum visibility conditions. * Schedule vessel movements during afternoons. b. MORNING SMOG/HAZE DURING SUMMER. * Daily occurrence except during northerly wind events. * Minimum visibility 0530 to 1030 local time. Improves as sea breeze develops. c. NAVIGATION HAZARDS. * Navigation hazards include: reduced visibility, mirages over flat coastal plain, muddy water and variable currents near mouth of Vardar River and extensive shoaling. * Visual navigation difficult.

SEASONAL SUMMARY OF HAZARDOUS WEATHER CONDITIONS

WINTER (November through February)

* N-NW'ly winds (Vardares) 34-47 kt, extremes over 63 kt
  - waves 4 to 7 ft in outer anchorage
  - wind chill may drop to -20°F (-29°C)
  - duration 1 to 5 days, rapid onset
* SW'ly winds (migratory cyclones) 17 to 27 kt. Strong northerlies likely to follow if cyclone passes eastward south of port.
  - waves 4 to 7 ft
  - occurs 2 to 3 per year, brings rainy weather
  - duration 1 to 2 days
* Fog, vsby near zero
  - occurs under high pressure ridge/center
  - only limited afternoon improvement
  - duration 2 or 3 days

SPRING (March through May)

* Strong currents in vicinity of Vardar River
  - occurs during spring flood period (Mar-Apr)

SUMMER (June through September)

* NE'ly wind (Etesian) 28 to 33 kt, only strongest reach area
  - increased cloudiness on day before onset
* Haze, reduced vsby until late morning
* Navigation hazards
  - extensive shoals, muddy water, haze and coastal mirages
* Sw'ly sea breeze prevails

AUTUMN (October)

* Rapid transition to winter-type weather around end of month

References

FICEURLANT, 1987: Port Directory for Thessaloniki, Greece. Fleet Intelligence Center Europe and Atlantic, Norfolk, VA.

Hydrographer of the Navy, 1968: Mediterranean Pilot. Volume IV, Hydrographer of the Navy, London, England.

Port Visit Information

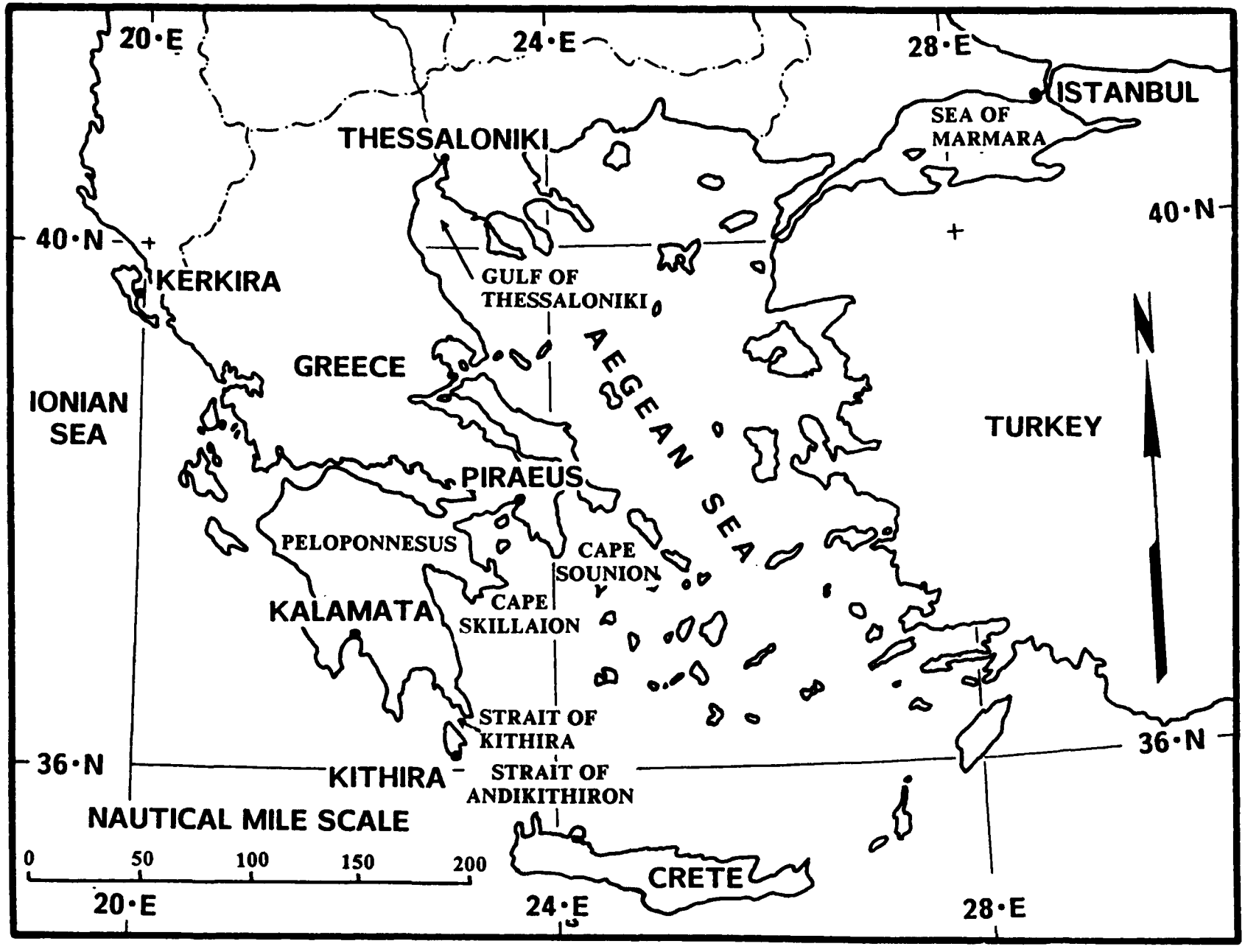
May 1990: NOARL Meteorologists R. Fett and R. Miller met with the Chief Pilot, Capt G. Georgious and Pilot, Capt S. Pantelis to obtain much of the information included in this port evaluation.

3. GENERAL INFORMATION

This section is intended for fleet meteorologists/ oceanographers and staff planners. Section 3.5 includes a general discussion of hazards and Table 3-2 provides a summary of vessel locations/situations, potential hazards, effect-precautionary/evasive actions, and advance indicators and other information by season.

3.1 Geographic Location

The Port of Thessaloniki, Greece is located in the northwest Aegean Sea on the northern shore of the Gulf of Thessaloniki near 40°38'N, 22° 56'E (FICEURLANT, 1987) (Figure 3-1). It is about 300 n mi north of Crete and about 315 n mi west of Istanbul.



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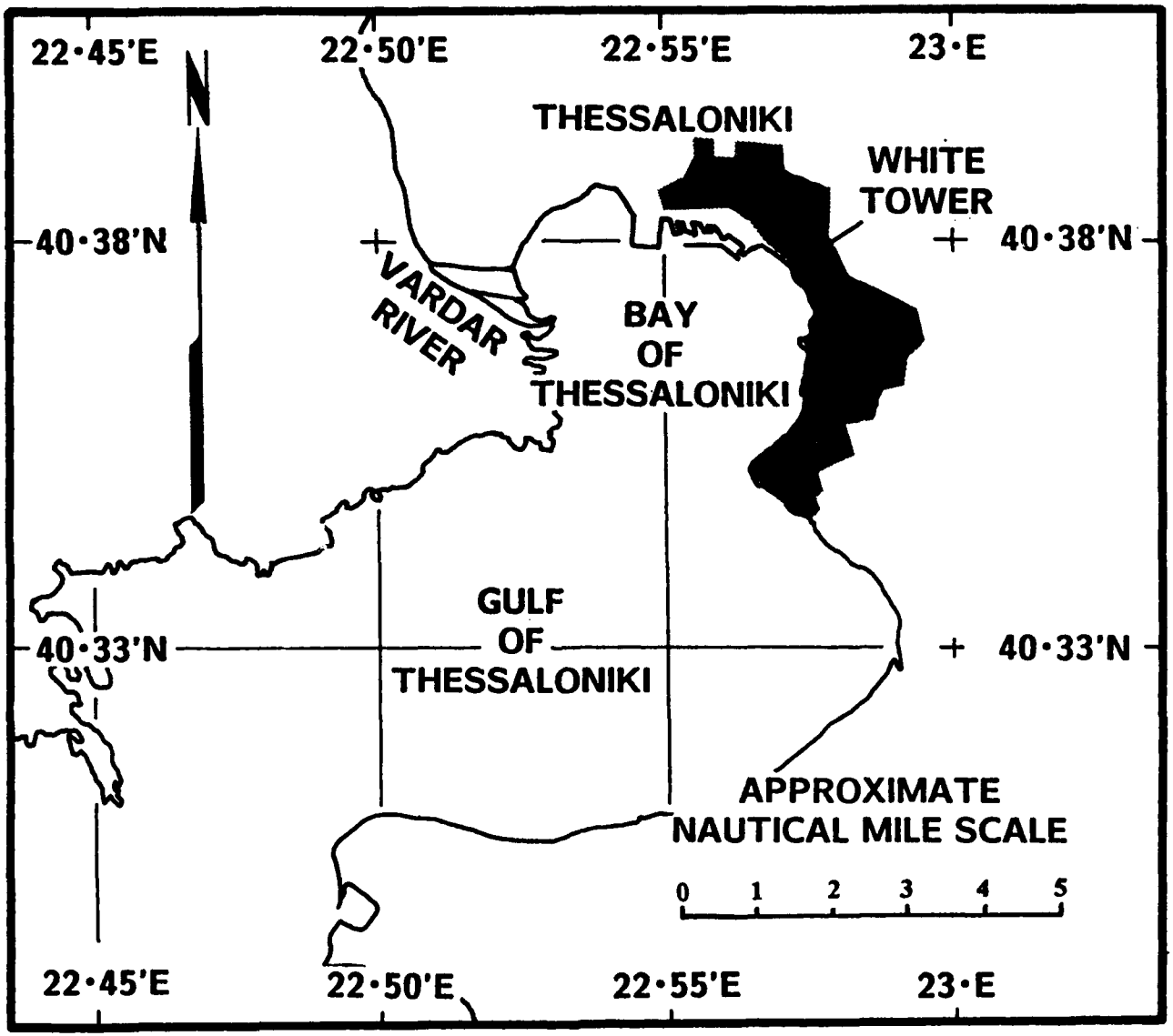

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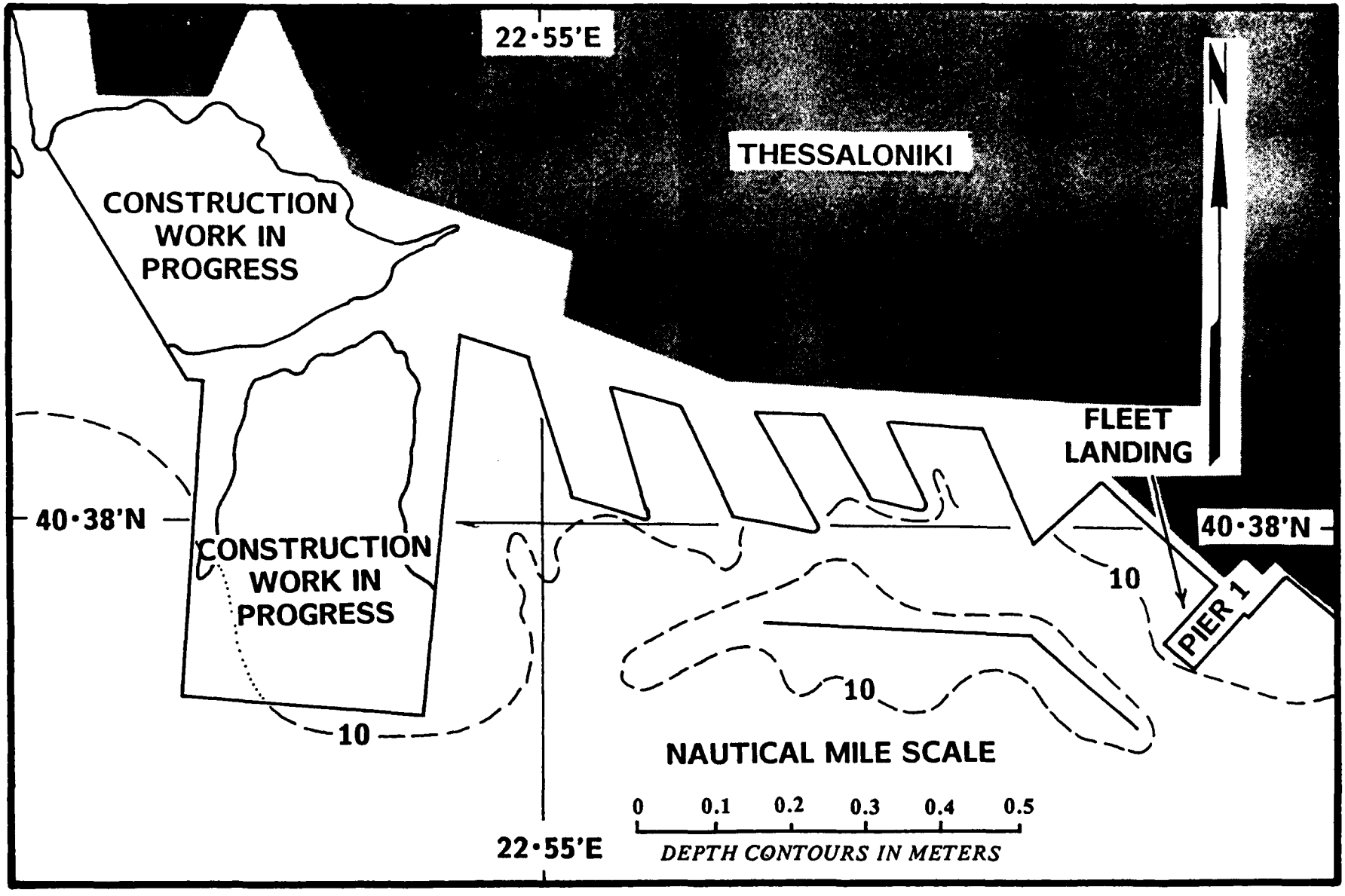

Figure 3-3. The Port of Thessaloniki, Greece.

The "conventional" port, located inboard from the breakwater, consists of five piers with a total length of about 4743 m (15,652 ft). A modern container terminal located just west of the conventional port provides a large sixth pier. Alongside depths of the conventional port range from 18 ft (5.5 m) to 40 ft (12 m). Any pier could be used for berthing. The preferred berthing for U.S. Navy ships, as well as the Fleet Landing, is on pier 1 (eastern pier).

Ships may anchor approximately 1 mile south of the eastern entrance (FICEURLANT, 1987) in depths of 48 ft (14.6 m) to 60 ft (18 m). Anchorage should be made as close as allowed (1/2 n mi) to the breakwater for maximum protection (Port Visit, 1990).

3.2 Qualitative Evaluation of the Port of Thessaloniki

The harbor provides protection from all wave conditions. During the strongest wind events, generally greater than 33 kt (force 8 or greater), mooring and cargo handling operations may be impeded. Anchorages are exposed and ships may drag anchor during strong wind events. Broad mud shoal areas west of the port and anchorage area result in a high incidence of groundings, but due to the soft mud bottom damage is generally minimal. Small boat operations outside the harbor are likely to be canceled during high wind events and can be hazardous during summer afternoons due to strong sea breezes and choppy wave conditions in the vicinity of the harbor.

Because of the infrequent severe wind conditions and the protection from deep water swell and limited fetch lengths for wind waves, the area seldom experiences extremely hazardous conditions. However, the anchorage is exposed to the winds, and extensive shoaling exists to the west of the harbor and in the vicinity of the entrance to the Bay making navigation hazardous during extreme wind conditions. Passage to/from this area during

strong winter northerly wind events should be avoided especially by vessels with large sail areas and/or those riding high in the water.

3.3 Currents and Tides

Tides and currents are negligible under normal circumstances (FICEURLANT, 1987). During strong southerly winds tides of 2-3 ft (3/4 m) may occur. During the spring flood period (March-April) strong currents may be experienced in the vicinity of the mouth of the Vardar River due to river freshets.

3.4 Visibility

During the November through March period, when a high pressure ridge is located over the area, persistent fog may occur. Early morning visibility of less than 50 m is typical with limited improvement during the afternoon to only a couple miles. These conditions will persist as long as the ridge and light wind conditions last, generally for two to three days.

During summer mornings (0530-1030) a low-lying haze layer restricts visibility to a few miles and makes visual navigation difficult. When the Etesian pattern brings northeasterly winds to the region blowing dust may cause temporary restrictions to visibility.

3.5 Hazardous Conditions

The Port of Thessaloniki and anchorage area are exposed to northerly and southerly winds. The anchorage and entrance to the harbor are exposed to southwesterly wind and locally generated waves.

The most common winter hazardous wind events are strong cold north-northwesterlies flowing out of the Vardar Gap. These winds are associated with the larger scale Bora patterns. (See Brody and Nestor (1980) for details on Boras, and NTAG Volume III (1980) for a case study). Migratory cyclones passing through the region can bring strong southerly winds and frontal weather and, if the cyclone tracks eastward south of the Port, cold strong northerly flow frequently follows. The terrain to the north and east of the port provides protection from all but the most intense summer Etesian northeasterly winds.

A seasonal summary of the various known environmental hazards that may be encountered in the Port of Thessaloniki area follows.

A. Winter (November through February)

The worst conditions for vessels in the harbor, anchorage area, or entering/departing the Bay occur during strong north-northwest winds. Locally these events are known as "Vardares", regionally they are known as Boras. They result from the funnelling of winds through the Vardar Gap when high pressure builds to the north and low pressure exists over the Mediterranean to the south. Due to the funneling effect, wind direction may be nearly perpendicular to the isobars. Brody and Nestor (1980) provide details on the synoptic conditions favorable for formation of Boras. In general, high pressure builds over southeastern Europe with low pressure, typically during winter a cyclone, over the eastern Mediterranean. Because the Bora reflects synoptic scale features, which can be identified at the surface up through and beyond the 500 mb level, the numerical model forecasts should provide good guidance for Vardares/Bora events. Winds of 38 to 47 kt (force 7-9) lasting for 1 to 5 days are typical. Maximum winds greater than 63 kt (force 12) were recorded on one occasion during the 20 years prior to the 1990 port visit. Strong Vardares can build waves of 4 to 7 ft (1 to 2 m) at the outer

anchorage and channel leading into the Bay. Freezing temperatures may be experienced during Vardares which, when combined with the winds, result in equivalent chill temperatures in the range of 0 to -20°F (-18 to -29°C) (Table 3-1).

Table 3-1. Wind Chill. The cooling power of the wind expressed as "Equivalent Chill Temperature" (adapted from Kotsch, 1983).

Wind Speed		Cooling Power of Wind expressed as "Equivalent Chill Temperature"								
Knots	MPH	Temperature (°F)								
Calm	Calm	40	35	30	25	20	15	10	5	0
		Equivalent Chill Temperature								
3-6	5	35	30	25	20	15	10	5	0	-5
7-10	10	30	20	15	10	5	0	-10	-15	-20
11-15	15	25	15	10	0	-5	-10	-20	-25	-30
16-19	20	20	10	5	0	-10	-15	-25	-30	-35
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55

Migratory cyclones approaching from the west (Genoa lows) or south (Sciroccos) result in moderate southwesterly winds of 17 to 27 kt (Force 5-6) with 4 to 7 ft (1-2 m) waves a few times each winter. Cloudy, rainy weather with scattered thunderstorms is experienced with these systems. If the migratory lows track into the eastern Mediterranean south of the Port, strong northerly winds may follow the passage of the low.

During periods when the European high ridges southward over the Balkan Peninsula near calm winds and fog with reduced visibility may persist for several days. Visibility may be restricted to near zero during night and morning hours with only slight improvement during the afternoons. These conditions will last as long as the ridge persists which typically is for 2 or 3 days.

The large scale winter pressure pattern has high pressure over the cold continental areas and low pressure over the relatively warm Mediterranean Sea. The prevailing wind at Thessaloniki during the winter is northerly reflecting the flow around the southern portion of the high pressure system over southeastern Europe and northern Balkan Peninsula. Strong winter northerly wind events are nearly always associated with cyclonic activity over the eastern Mediterranean resulting in a steep pressure gradient over the Balkan Peninsula between the high over Europe and the low to the south.

B. Spring (March through May)

The best weather conditions are experienced during spring. Winter-type Bora patterns are weak, and the summer Etesian pattern has not yet developed. Strong currents may be encountered near the mouth of the Vardar River during March and April during flooding periods.

C. Summer (June through September)

Summers are windy with alternating southerly sea breezes and occasional moderate northeasterlies during strong Etesian events. Wind and wave conditions may be hazardous to small boat operations. Etesian wind speeds are likely to decrease in the afternoon due to offset by sea breeze. Visibility is typically restricted in haze, and blowing dust accompanies the northeasterly wind events. Visual navigation may be hindered.

D. Autumn (October)

Autumn weather conditions are good. The primary hazardous factor is the tendency for rapid transition to winter conditions which may catch people, with only spring and/or summer experience, unaware. The first winter type migratory low can be expected any time after the third week of October.

3.6 Harbor Protection

The Port of Thessaloniki is protected from all wave conditions. The strongest wind events will result in hazardous wind and/or wave conditions for cargo handling, berthing operations, and alongside or small boat operations outside the harbor. The anchorage is exposed to the winds and anchor dragging may occur.

3.6.1 Wind and Weather

The Port of Thessaloniki is exposed to both southerly and northerly strong wind events. The anchorage is also fully exposed and there are no alternate local sheltered anchorage areas. Extensive shoaling to the west of the anchorage, extending westward to beyond the Bay entrance, results in navigation hazards. Restricted visibility due to haze, frequent mirages over the low coastal regions, and muddy water combine to create additional navigation hazards. The mud bottom extends into the anchorage area limiting the holding. Anchor dragging is likely for large sail area vessels particularly during the first hour or so until the anchor can dig deep into the mud bottom.

3.6.2 Waves

Wave problems are limited to small craft operations outside the harbor and alongside operations in the anchorage area. Waves of 4 to 7 ft (1-2 m) may be experienced during summer or winter. Spring and autumn experience lower winds and wave heights. Deep water swell does not affect the area.

3.7 Protective and Mitigating Measures

3.7.1 Moving to a new Anchorage

There are no alternate anchorages in the local area.

3.7.2 Scheduling

During summer sea breezes increase during the afternoon reaching maximum speeds in late afternoon and early evening. Morning periods are frequently near calm during all seasons. Minimum visibilities due to fog and haze are experienced during the mornings with lightest wind conditions. Berthing operations and small boat operations are likely to be curtailed during strong Bora events. Under strong Bora conditions there may be little or no abatement of winds during the night and morning periods due to reenforcement of the gradient winds by the land breeze. With weaker northerly wind events the sea breeze may cancel out the gradient flow and near calm conditions may develop during the afternoon. This is most likely during summer when the sea breeze regime is strongest.

3.7.3 Small Boat Operations

All of the wind factors addressed in the preceding paragraph on scheduling relate to small boat operations. The most protected Fleet Landing is inside pier 1 at the eastern end of the harbor. Strong summer sea breeze conditions during late afternoon/early evening make conditions near the harbor entrance and exposed areas outside the harbor hazardous due to onshore winds and choppy wind waves. Except during the most extreme wind conditions, light wind conditions will prevail during either the morning (sea breeze regime) or later in the day (weak northerlies regimes). As a result there will be a period of favorable conditions for small boat and alongside operations at some time during most days.

3.8 Local Indicators of Hazardous Weather Conditions

No local indicators were noted during the Port Visit of 1990. Reiter (1971) reported that increasing cloudiness over the Balkan Peninsula and Aegean Sea on the day preceding the establishment of a strong Etesian wind period was a well-known fact by local fishermen. During the periods of May-June and September-October thunderstorms and lightning frequently occur on the day preceding the outbreak of the Etesian as well as on the first day of the Etesian. During July and August, when the most stable atmospheric conditions exist over the Mediterranean, scattered altocumulus are typically noted on the day preceding the onset of the Etesian.

3.9 Summary of Problems, Actions, and Indicators

Table 3-2 is intended to provide easy-to-use seasonal references for forecasters on ships using the Port of Thessaloniki. Table 2-1 (Section 2) summarizes Table 3-2 and is intended primarily for use by ship captains.

(1)

Table 3.2. Potential Problem Situations a

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAUT
1. Harbor Operations/ Anchorage Strongest in Winter and Early Spring	a. NW-N'ly Winds/Waves - Locally called Vardares, regionally known as Bora. Winds 34-47 kt (Force 8-9), waves 4-7 ft (1-2 m) and building offshore. Winter wind chill temperatures to -20°F (-29°C). Durations of 1 to 5 days. Extreme event during period of 1971-1990 had 63 kt (Force 12) winds. Strongest winds may occur in morning period.	a. Most hazardous eve and for vessels at an handling may have to events. Some wind ab afternoon/evening per chills will necessita operations. Vessels breakwater as allowed grounding hazards due
Summer Event	b. N-NE'ly Winds/Waves - Occur during strongest regional Etesians. Winds 28-33 kt (Force 7), waves 3 to 5 ft (1-1 m) and building offshore. May raise dust that restricts visibility. Winds likely to decrease in afternoons.	b. Reversal of prevail southerly sea breeze t flow will affect vesse alongside operations, Consideration should t direction effects. Mi during afternoons when northerly gradient wir
Winter Event	c. S'ly, Wind/Waves - Occurs during cyclone/frontal passages. Winds 17 to 27 kt (Force 5-6), waves 4-7 ft (1-2 m). Low clouds and precipitation, reduced visibility. May be followed by strong northwesterly winds.	c. S'ly winds may resu drifting of vessels to shoaling which extends harbor southwestward t the Bay near the mouth Vessels should anchor side of the channel an proceed with due cauti

(2)

ituations at the Port of Thessaloniki, Greece -- All Seasons

PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
rdous events for operations in harbor els at anchorage. Berthing and cargo have to be curtailed during strong e wind abatement likely during ening period. Low temperature/wind necessitate cold weather gear and Vessels should anchor as close to s allowed, offshore wind minimizes zards due to anchor dragging.	a. Vardares are the result of <u>winter time</u> northerly flow through the Vardar Gap which is forced by synoptic scale Bora wind events. The basic synoptic ingredients of Bora events is surface high pressure over Europe and low pressure over the eastern Mediterranean. During winter the 500 mb circulations starting two days before the local onset of a Vardares typically has 500 mb ridging building into the north Atlantic and then moving eastward over western Europe with a large amplitude trough in advance of the ridge moving eastward across Europe. At the surface a migratory high moves east-southeastward from the United Kingdom to central Europe area while surface cyclones are moving east-southeastward from the central to the eastern Mediterranean and across northern Europe. Numerical guidance should be reliable.
of prevailing day-time onshore a breeze to offshore northeasterly fect vessel maneuvering, berthing, erations, and small boat operations. n should be given to impact of wind fects. Minimum wind speeds likely noons when sea breeze offsets adient winds.	b. During <u>summer time</u> strong Etesian events develop when the thermal trough that extends westward from Asia Minor along the southern coast of Turkey intensifies. Increasing cloudiness develops over the Balkan Peninsula area the day before onset of an Etesian. During July and August the cloudiness is in the form of altocumulus on the day before onset, during May-June and September-October periods scattered thunderstorm activity develops on the day before and first day of an Etesian. To reach Thessaloniki Etesian must extend to 5000 ft, use 850 mb information.
s may result in anchor dragging or vessels toward areas of extensive ch extends from just west of the vestward to beyond the entrance to the mouth of the Vardar River. d anchor and maneuver to the eastern channel and anchorage area and due caution.	c. Migratory cyclones and fronts result from either Genoa lows or Sciroccos. In either case the passage of this system over the local area will be late in a given storm's development cycle, therefore advance warning of an approaching storm should be evident a day or more in advance by monitoring cyclogeneic events moving across Italy or out of North Africa.

(1)

Table 3.2 (cc

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAI
2. Small Boats - Anchorage and/or - Fleet Landing Strongest in Winter	a. NW-N'ly Winds/Waves - Locally called Vardares, regionally known as Bora. Winds 34-47 kt (Force 8-9), waves 4-7 ft (1-2 m) and building offshore. Winter wind chill temperatures to -20°F (-29°C). Durations of 1 to 5 days. Extreme event during period of 1971-1990 had 63 kt (Force 12) winds. Strongest winds may occur in morning period.	a. Small boat runs t hazardous during Var curtailed during str some abatement of wi evening should be cc boat runs. Vessels allowable.
Summer Event	b. N-NE'ly Winds/Waves - Occur during strongest regional Etesians. Winds 28-33 kt (Force 7), waves 3 to 5 ft (1-1½ m) and building offshore. May raise dust that restricts visibility. Winds likely to decrease in afternoons.	b. Small boat runs t hazardous but not Blowing dust may res speeds likely to dec skies are relatively (sea breeze offset).
Winter Event	c. S'ly, Wind/Waves - Occurs during cyclone/frontal passages. Winds 17 to 27 kt (Force 5-6), waves 4-7 ft (1-2 m). Low clouds and precipitation, reduced visibility. May be followed by strong northwesterly winds.	c. Onshore wind and the sea wall outsid and small boat oper inner harbor area. strongest from mid-

able 3.2 (continued)

- PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
oat runs to/from anchorage will be during Vardares and may have to be during strong events. The tendency for ment of winds during afternoon and ould be considered for scheduling small Vessels should anchor as close in as	a. Vardares are the result of <u>winter time</u> northerly flow through the Vardar Gap which is forced by synoptic scale Bora wind events. The basic synoptic ingredients of Bora events is surface high pressure over Europe and low pressure over the eastern Mediterranean. During winter the 500 mb circulations starting two days before the local onset of a Vardares typically has 500 mb ridging building into the north Atlantic and then moving eastward over western Europe with a large amplitude trough in advance of the ridge moving eastward across Europe. At the surface a migratory high moves east-southeastward from the United Kingdom to central Europe area while surface cyclones are moving east-southeastward from the central to the eastern Mediterranean and across northern Europe. Numerical guidance should be reliable.
oat runs to/from anchorage will be but not likely to be canceled. st may restrict visibility. Wind ely to decrease during afternoon if relatively clear and land area warms e offset).	b. During <u>summer</u> strong Etesian events develop when the thermal trough that extends westward from Asia Minor along the southern coast of Turkey intensifies. Increasing cloudiness develops over the Balkan Peninsula area the day before onset of an Etesian. During July and August the cloudiness is in the form of altocumulus on the day before onset, during May-June and September-October periods scattered thunderstorm activity develops on the day before and first day of an Etesian.
wind and waves affect all areas along ll outside the harbor, Fleet Landing boat operations may be limited to the or area. Winds are likely to be from mid-day into evening.	c. Migratory cyclones and fronts result from either Genoa lows or Sciroccos. In either case the passage over the local area will be late in a given storm's development cycle, therefore advance warning of an approaching storm should be evident a day or more in advance by monitoring cyclogeneic events moving across Italy or out of North Africa.

(1)

Table 3.2 (co

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAUTI(
3. Arriving/Departing Winter - Spring Conditions	a. Fog - Reduced visibility - Near zero visibility may persist for 2 or 3 days with slight improvement during afternoons.	a. Coupled with extensi and strong currents nea spring flood stage make navigation. Proceed wi
Summer - Autumn	b. Haze and smog during light wind periods - Generally during mornings, significant impact on visual navigation.	b. Restricted visual n and muddy water result accidents. Proceed wi
Winter Event	c. S'ly, Wind/Waves - Occurs during cyclone/frontal passages. Winds 17 to 27 kt (Force 5-6), waves 4-7 ft (1-2 m). Low clouds and precipitation, reduced visibility. May be followed by strong northwesterly winds.	c. Onshore wind and wa the sea wall outside t and small boat operati inner harbor area. Wi strongest from mid-day

(2)

Table 3.2 (continued)

- PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
with extensive shoaling, muddy water, currents near mouth of Vardar during d stage makes for hazardous Proceed with due caution.	a. Fog events occur when high pressure ridging extends southward over the Balkan Peninsula and the ridgeline is over or near the local area. This is a synoptic scale event, numerical forecasts should provide skillful guidance.
ed visual navigation aids, shoaling ater results in groundings and Proceed with due caution.	b. These are local events developing under synoptic scale high pressure cells and very stable low level atmospheric conditions (inversions). Conditions may persist for several days during summer when gradient winds and local sea breezes offset each other resulting in near calm winds.
wind and waves affect all areas along ll outside the harbor, Fleet Landing oat operations may be limited to the or area. Winds are likely to be rom mid-day into evening.	c. Migratory cyclones and fronts result from either Genoa lows or Sciroccos. In either case the passage of this system over the local area will be late in a given storm's development cycle, therefore advance warning of an approaching storm should be evident a day or more in advance by monitoring cyclogeneic events moving across Italy or out of North Africa.

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*Now Naval Research Laboratory, Monterey, CA 93943-5006.

Port Visit Information

May 1990: NOARL Meteorologists R. Fett and R. Miller met with the Chief Pilot, Capt G. Georgious and Pilot, Capt S. Pantelis to obtain much of the information included in this port evaluation.

APPENDIX A

General Purpose Oceanographic Information

This section provides some general definitions regarding waves and is extracted from H.O. Pub. No. 603, Practical Methods for Observing and Forecasting Ocean Waves (Pierson, Neumann, and James, 1955).

Definitions

Waves that are being generated by local winds are called "SEA". WAVES that have traveled out of the generating area are known as "SWELL". Seas are chaotic in period, height and direction while swell approaches a simple sine wave pattern as its distance from the generating area increases. An in-between state exists for a few hundred miles outside the generating area and is a condition that reflects parts of both of the above definitions. In the Mediterranean area, because its fetches and open sea expanses are limited, SEA or IN-BETWEEN conditions will prevail. The "SIGNIFICANT WAVE HEIGHT" is defined as the average value of the heights of the one-third highest waves. PERIOD and WAVE LENGTH refer to the time between passage of, and distances between, two successive crests on the sea surface. The FREQUENCY is the reciprocal of the period ($f = 1/T$); therefore as the period increases the frequency decreases. Waves result from the transfer of energy from the wind to the sea surface. The area over which the wind blows is known as the FETCH, and the length of time that the wind has blown is the DURATION. The characteristics of waves (height, length, and period) depend on the duration, fetch, and velocity of the wind. There is a continuous generation of small short waves from the time the wind starts until it stops. With continual transfer of energy from the wind to the sea surface the waves grow with the older waves leading the growth and spreading the energy over a greater range of frequencies. Throughout the growth cycle a SPECTRUM of ocean waves is being developed.

A Beaufort Scale table with related wave effects is shown on the following page.

BEAUFORT SCALE

Beaufort Number	Wind Speed Knots	Wind Speed MPH	Seaman's term	Effects observed at sea	Term and height of Waves in meters
0	Under 1	Under 1	Calm	Sea like mirror.	Calm, glassy, 0
1	1-3	1-3	Light air	Ripples with appearance of scales; no foam crests.	
2	4-6	4-7	Light breeze	Small wavelets; crests of glassy appearance, not breaking	Rippled, less than 0.5
3	7-10	8-12	Gentle breeze	Large wavelets; crests begin to break; scattered whitecaps.	Smooth, 0.5
4	11-16	13-18	Moderate breeze	Small waves, becoming longer; numerous whitecaps.	Slight, 1.0
5	17-21	19-24	Fresh breeze	Moderate waves, taking longer form; many whitecaps; some spray.	Moderate, 1.0-2.5
6	22-27	25-31	Strong breeze	Larger waves forming; whitecaps everywhere; more spray.	Rough, 2.5-4.0
7	28-33	32-38	Moderate gale	Sea heaps up; white foam from breaking waves begins to be blown up in streaks.	
8	34-40	39-46	Fresh gale	Moderate high waves; edges of crests begin to break; foam is blown in steaks.	Very rough, 4.0-6.0
9	41-47	47-54	Strong gale	High waves; sea begins to roll; dense streaks of foam; spray may reduce visibility.	
10	48-55	55-63	Whole gale	Very high waves with overhanging crests; sea takes white appearance as foam is blown in very dense streaks; rolling is heavy and visibility reduced.	High, 6.0-9.0
11	56-63	64-72	Storm	Exceptionally high waves; sea covered with white foam patches; visibility still more reduced.	Very high, 9.0-13.5
12 13 14 15 16 17	64-71 72-80 81-89 90-99 100-108 109-118	73-82 83-92 93-103 104-114 115-125 126-136	Hurricane	Air filled with foam; sea completely white with driving spray; visibility greatly reduced. Winds of force 12 and above very rarely experienced on land; usually accompanied by widespread damage.	Phenomenal, greater than 13.5

SNDL

21A1	CINCLANTFLT
21A3	CINCUSNAVEUR
22A1	COMSECONDFLT
22A3	COMSIXTHFLT
23B3	Special Force Commander EUR
24A1	Naval Air Force Commander LANT
24D1	Surface Force Commander LANT
24E	Mine Warfare Command
24G1	Submarine Force Commander LANT
26QQ1	Special Warfare Group LANT
28A1	Carrier Group LANT (2)
28B1	Cruiser-Destroyer Group LANT (2)
28D1	Destroyer Squadron LANT (2)
28J1	Service Group and Squadron LANT (2)
28K1	Submarine Group and Squadron LANT
28L1	Amphibious Squadron LANT (2)
29A1	Guided Missile Cruiser LANT
29B1	Aircraft Carrier LANT
29D1	Destroyer LANT (DO 931/945 Class)
29E1	Destroyer LANT (DO 963 Class)
29F1	Guided Missile Destroyer LANT
29G1	Guided Missile Frigate (LANT)
29I1	Frigate LANT (FF 1098)
29J1	Frigate LANT (FF 1040/1051 Class)
29K1	Frigate LANT (FF 1052/1077 Class)
29L1	Frigate LANT (FF 1078/1097 Class)
29N1	Submarine LANT (SSN)
29Q	Submarine LANT SSBN
29R1	Battleship Lant (2)
29AA1	Guided Missile Frigate LANT (FFG 7)
29BB1	Guided Missile Destroyer (DDG 993)
31A1	Amphibious Command Ship LANT (2)
31B1	Amphibious Cargo Ship LANT
31G1	Amphibious Transport Ship LANT
31H1	Amphibious Assault Ship LANT (2)
31I1	Dock Landing Ship LANT
31J1	Dock Landing Ship LANT
31M1	Tank Landing Ship LANT
32A1	Destroyer Tender LANT
32C1	Ammunition Ship LANT
32G1	Combat Store Ship LANT
32H1	Fast Combat Support Ship LANT
32N1	Oiler LANT
32Q1	Replenishment Oiler LANT
32S1	Repair Ship LANT
32X1	Salvage Ship LANT

32DD1	Submarine Tender LANT
32EE1	Submarine Rescue Ship LANT
32KK	Miscellaneous Command Ship
32QQ1	Salvage and Rescue Ship LANT
32TT	Auxiliary Aircraft Landing Training Ship
42N1	Air Anti-Submarine Squadron VS LANT
42P1	Patrol Wing and Squadron LANT
42BB1	Helicopter Anti-Submarine Squadron HS LANT
42CC1	Helicopter Anti-Submarine Squadron Light HSL LANT
C40	Monterey, Naples, Sigonella and Souda Bay only
FD2	Oceanographic Office - NAVOCEANO
FD3	Fleet Numerical Oceanography Center - FLENUMOCEANCEN
FD4	Oceanography Center - NAVEASTOCEANCEN
FD5	Oceanography Command Center - COMNAVOCEANCOM (Rota)

copy to:

21A2	CINCPACFLT
22A2	Fleet Commander PAC
24F	Logistics Command
24H1	Fleet Training Command LANT
28A2	Carrier Group PAC (2)
29B2	Aircraft Carrier PAC (2)
29R2	Battleships PAC (2)
31A2	Amphibious Command Ship PAC (2)
31H2	Amphibious Assault Ship PAC (2)
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